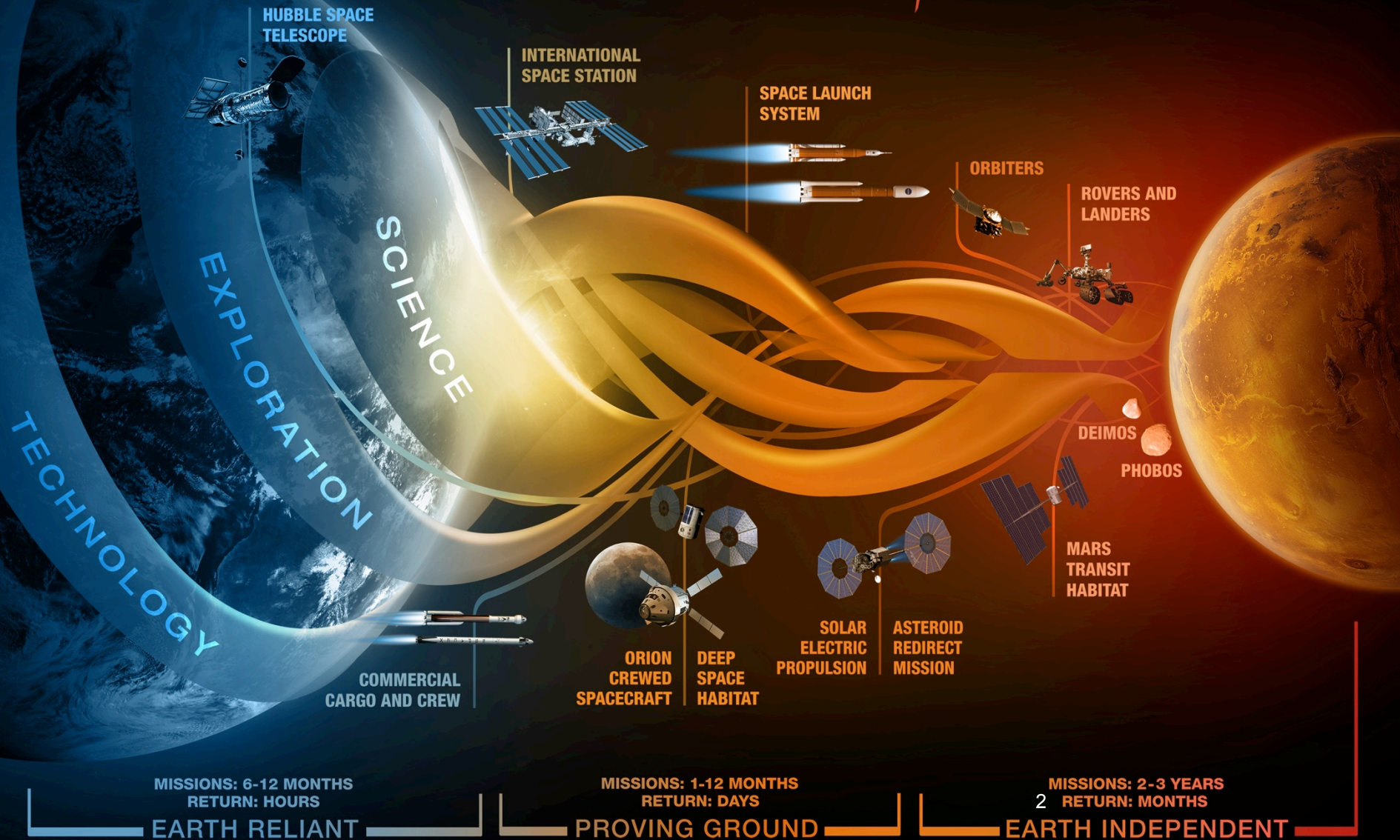




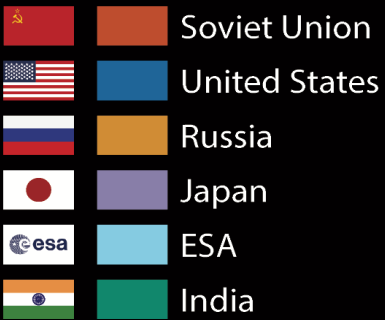
Status of Human Exploration & Operations Mission Directorate

Bill Gerstenmaier | Associate Administrator | HEO

JOURNEY TO MARS

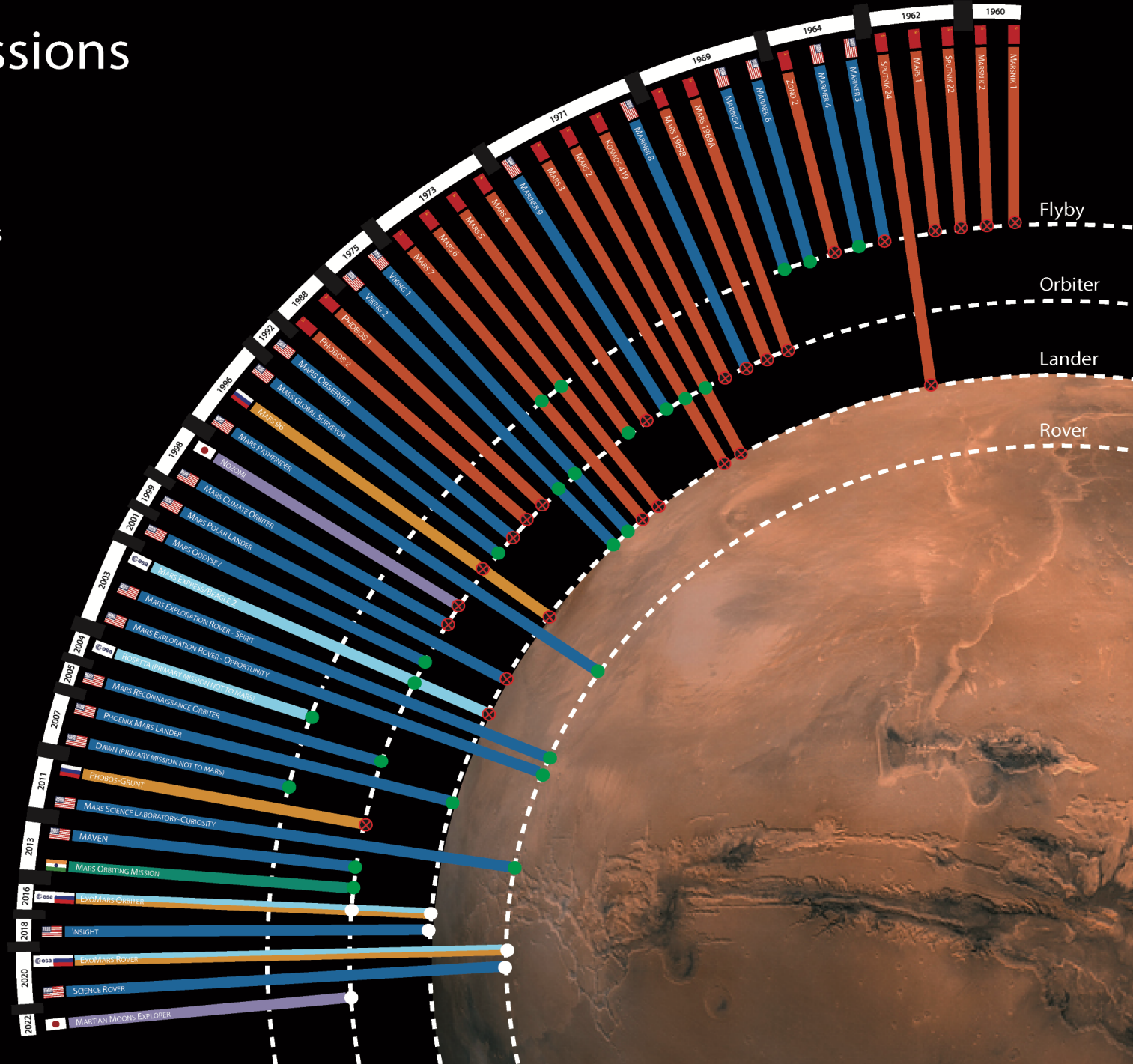


Robotic Missions to Mars

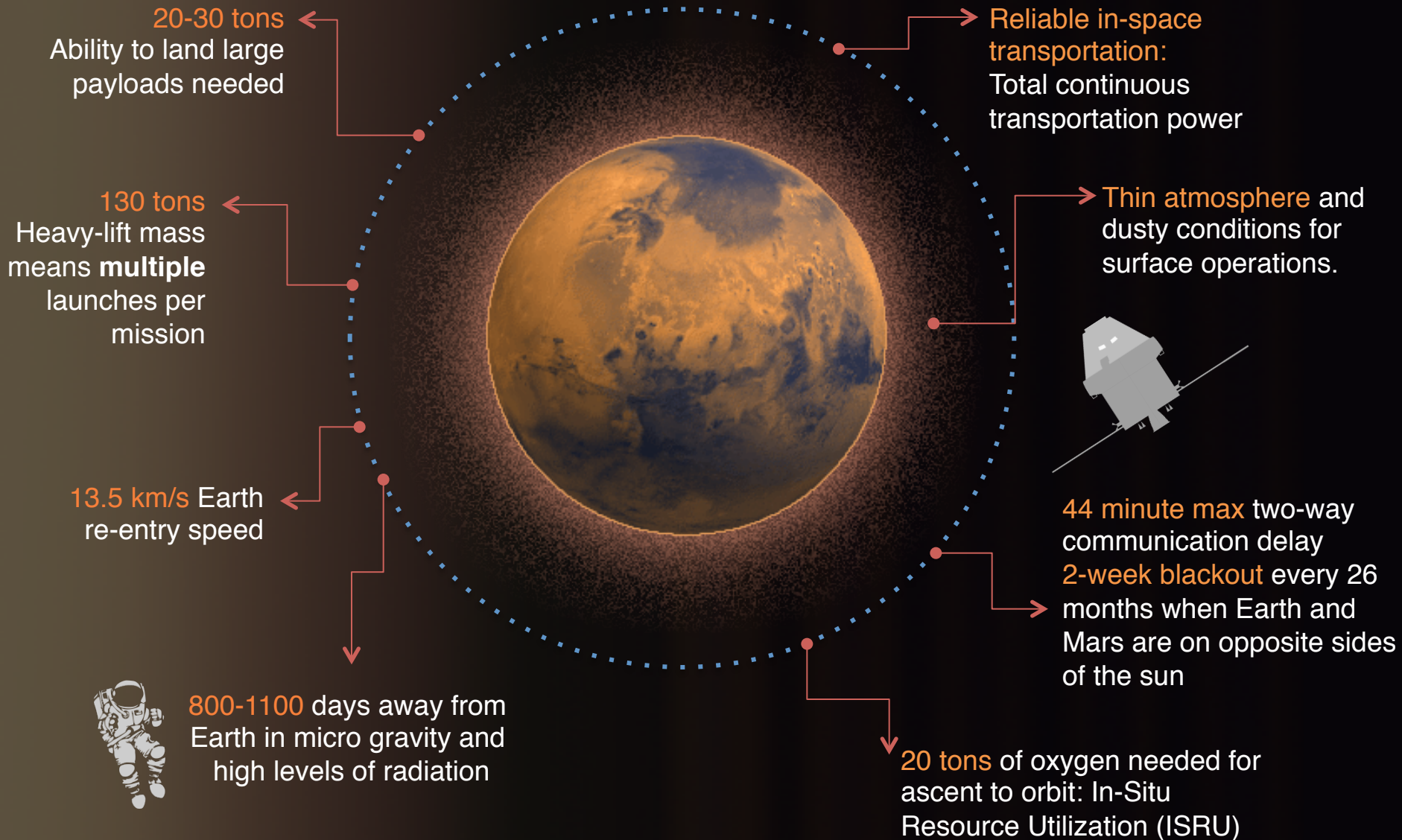


- ❌ Mission Failure
- Mission Success
- Future Destination

- **25 of 44**
Mission Failures



Human Exploration of Mars is Hard



Human Space Exploration Phases From ISS to the Surface of Mars



Today

Phase 0: Exploration Systems
Testing on ISS

Ends with testing,
research and
demos complete*

Asteroid Redirect-Crewed
Mission Marks Move from
Phase 1 to Phase 2

Phase 1: **Cislunar Flight
Testing** of Exploration
Systems

Ends with one year
crewed Mars-class
shakedown cruise

Phase 2: **Cislunar Validation**
of Exploration Capability

Phase 3: Crewed Missions
Beyond Earth-Moon System

Phase 4a: Development
and robotic
preparatory missions

Phase 4b: Mars
Human Landing
Missions



Planning for the details and specific
objectives will be needed in ~2020

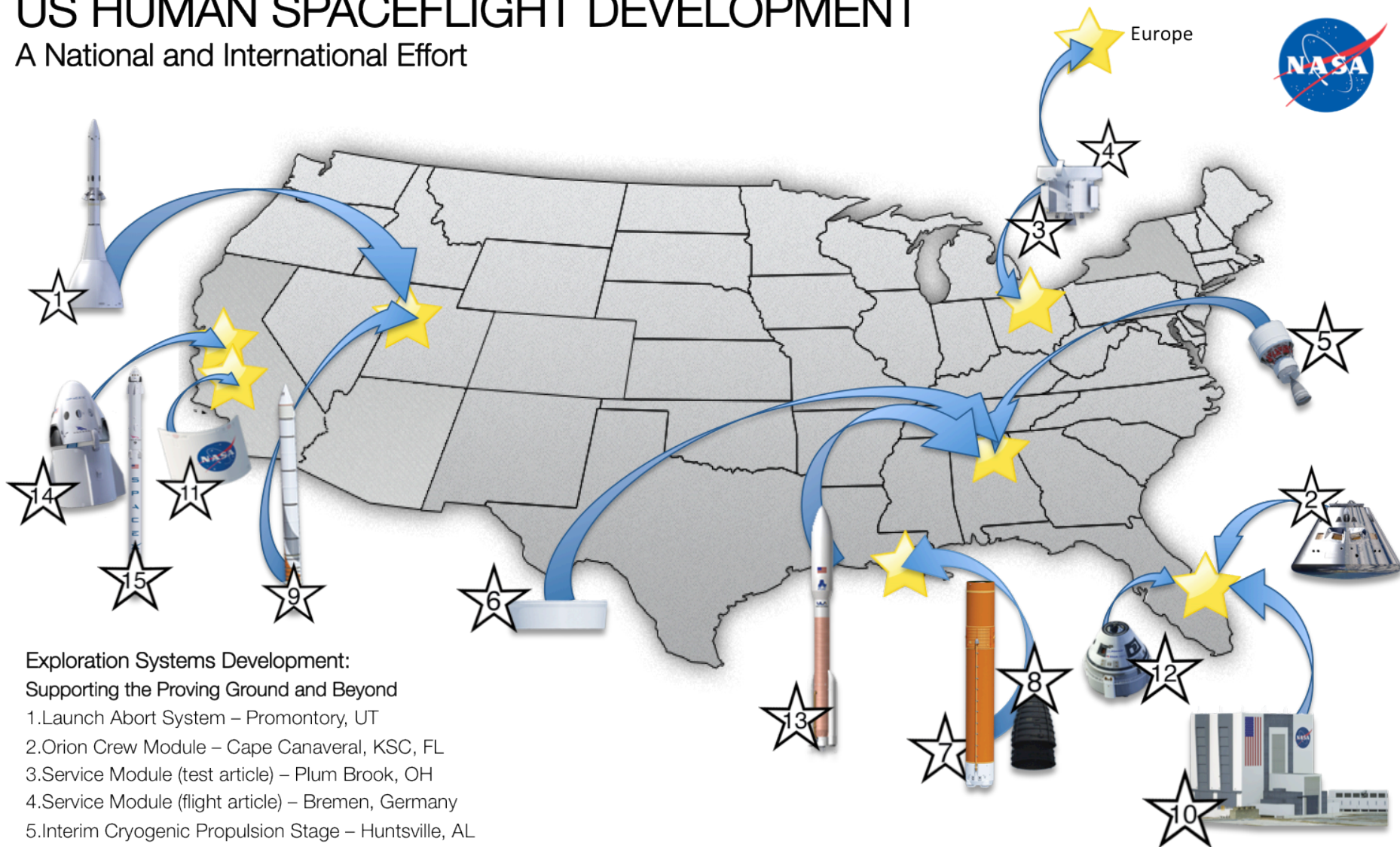
* There are several other
considerations for ISS end-of-life

Mid-2020s

2030

US HUMAN SPACEFLIGHT DEVELOPMENT

A National and International Effort



Exploration Systems Development:

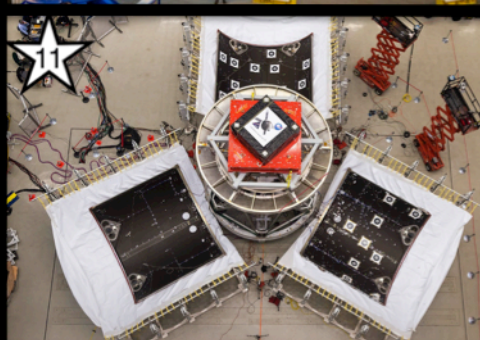
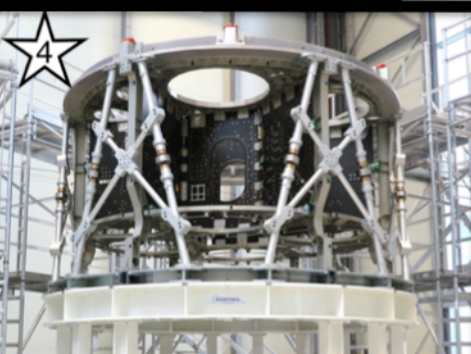
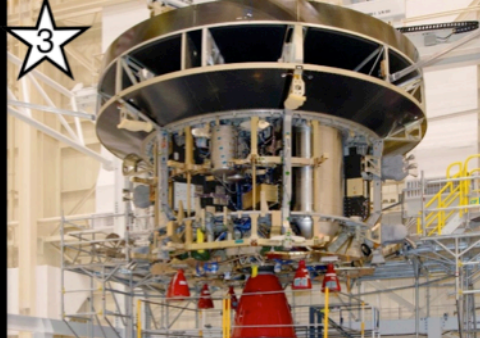
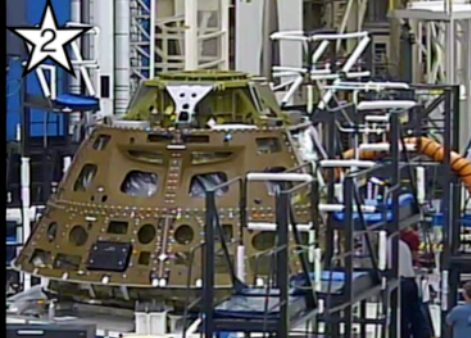
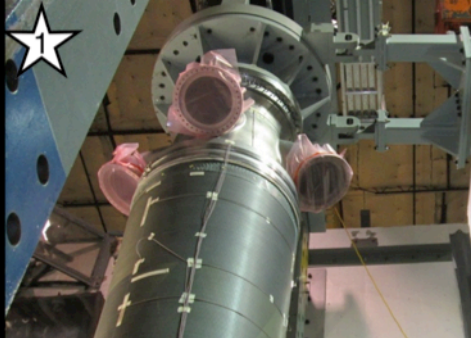
Supporting the Proving Ground and Beyond

1. Launch Abort System – Promontory, UT
2. Orion Crew Module – Cape Canaveral, KSC, FL
3. Service Module (test article) – Plum Brook, OH
4. Service Module (flight article) – Bremen, Germany
5. Interim Cryogenic Propulsion Stage – Huntsville, AL
6. Launch Vehicle Stage Adaptor – Huntsville, AL
7. Core Stage – New Orleans, LA
8. Core Stage Engines – SSC, MS
9. Boosters – Promontory, UT
10. Ground Systems – Cape Canaveral, KSC, FL
11. Fairings – Canoga Park, CA

Commercial Spaceflight Development

Supporting the International Space Station

12. Boeing Starliner – Cape Canaveral, KSC, FL
13. ULA Atlas V – Decatur, AL
14. Space-X Crew Dragon – Hawthorne, CA
15. Space-X Falcon 9 – Hawthorne, CA



ISS Research and Development Conference San Diego, California July 12-14, 2016



Discussed medical technology advancements
with Dr. Ellen Stofan and implication for astronaut health



Discussed 1 year crew and twins research
And implications for Journey to Mars



Discussed advancements in technology applications
for space and the broader technology industry

Other Highlights:

714 registered participants
(increase of about 20 over last year)

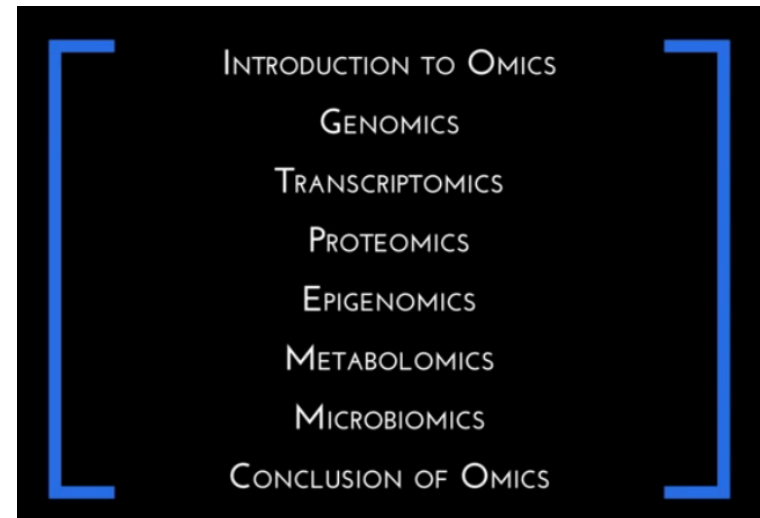
Workshops targeted for new users

Forums for linking together investors
with emerging companies

Twins Study and Omics Video Series



<http://www.nasa.gov/twins-study>



Omics Video Series:

<http://www.nasa.gov/content/exploring-space-through-you-omics>

OMICS Mini-series, Videos 1-6 Now available to view; videos 7-8 available by Aug 2016

Advancing Economic Development in LEO via Commercial Use of Limited Availability, Unique International Space Station Capabilities RFI



NASA is investigating options and approaches to expedite commercial activity in Low Earth Orbit (LEO).

Specifically, NASA is looking to increase private sector demand for space research and expand on the work of Center for the Advancement of Science in Space (CASIS), the manager of the ISS National Laboratory.

NASA is not only interested in technical solutions to advance these goals, but also in contract or agreement structures that potential offers' would see as beneficial to advance private sector demand for low Earth orbit research.

Some unique capabilities that could be made available include:

•Currently available

- Common Berthing Mechanism ports, if the user provides equivalent capability to maintain ISS functionality
- Trunnion Pins
- Other unique interfaces or capabilities of the ISS as suggested by the offeror

•Available in the future

- Common Berthing Mechanism attachment site at Node 3 Aft

RFI was released on July 1 – Responses are due July 29, 2016

FedBizzOpps.gov: <https://www.fbo.gov/notices/203c8f1a3a4f0497cdea6dbf205ee2b1>

Commercial Resupply Services

CRS-1 Flight History



- **CRS-1 Flights Flown To Date**

- CY 2012
 - SpX-1
- CY 2013
 - SpX-2
- CY 2014
 - SpX-3 & SpX-4; Orb-1, Orb-2, Orb-3 (Lost)
- CY 2015
 - SpX-5, SpX-6 & SpX-7 (Lost); OA-4
- CY 2016
 - SpX-8, SpX-9; OA-6

- **CRS-1 Future Flights planned**

- CY 2016
 - SpX-10; OA-5 & OA-7
- CY 2017
 - SpX-11, SpX-12, SpX-13, SpX-14; OA-8 & OA-9
- CY 2018
 - SpX-15, SpX-16, SpX-17 & SpX-18; OA-10 & OA-11

Commercial Resupply Services

CRS-2 Integration



- **CRS-2 Contract award was announced on Jan. 14, 2016**
 - Awardees are Orbital-ATK Inc. (OA), Sierra Nevada Corporation (SNC) and SpaceX (SpX)
 - Contractor post award briefings were completed in April 2016
 - ISS Integration work has been ordered for each provider as of 6/3/16
 - SNC held it's Integration Review (IR) #1 on 6/8/16 with IR #2 planned for 7/20/16
 - OA IR #1 was completed on 6/21/16 with IR #2 completed on 7/7/16
 - SpX IR #1 is scheduled for 7/27/16 with IR #2 planned for September (date to be set at IR#1)
 - A minimum of six missions will be ordered from each provider
 - CRS-2 missions are planned for launch in 2019

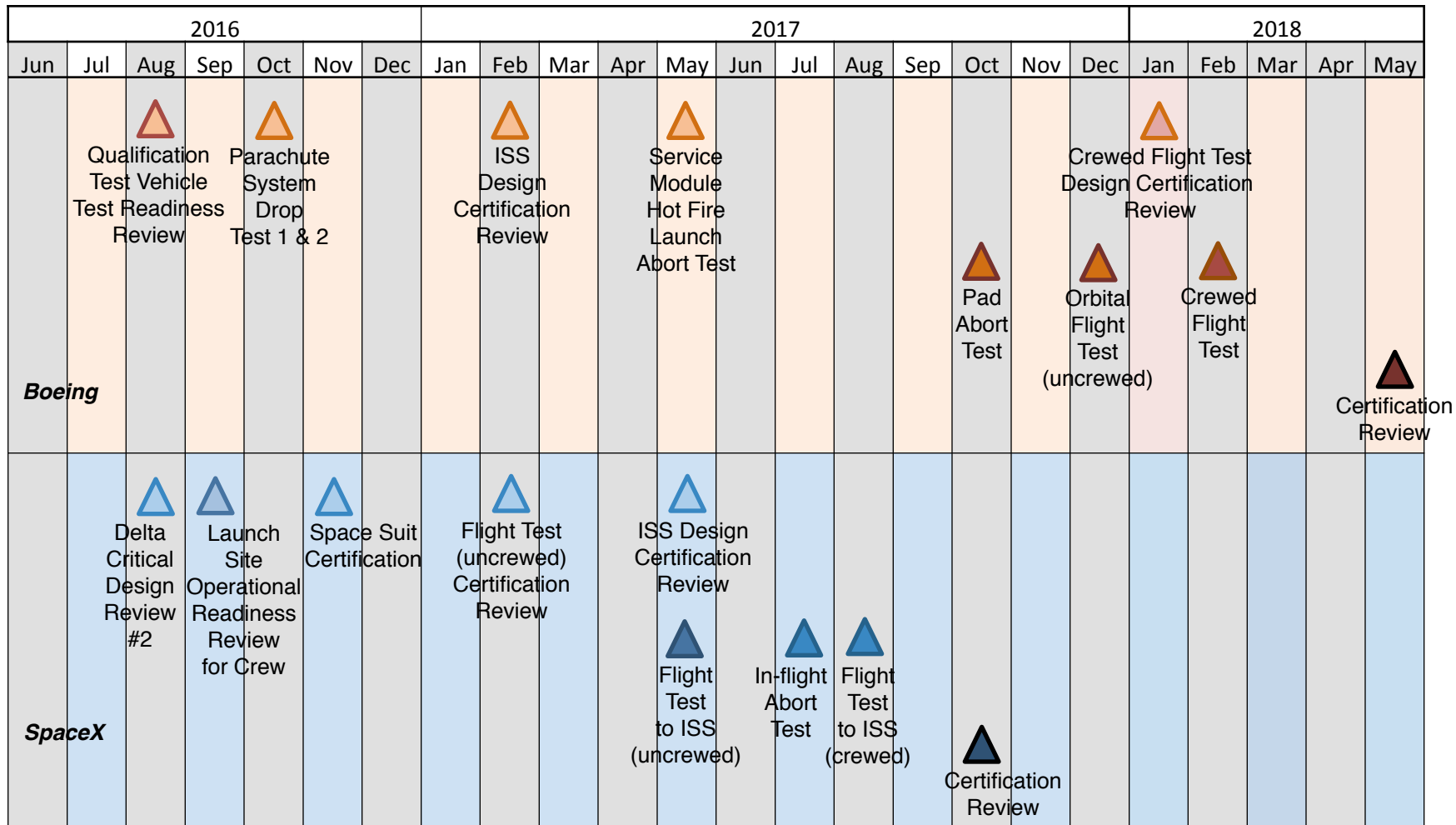
CCP Accomplishments



CCP has made significant progress over the last quarter, notably:

- **Boeing and SpaceX are advancing their design concepts**
 - Actively building and testing hardware to inform design
 - Engaging in meaningful insight with NASA
 - Addressing important design challenges
- **CCP continues to burn down key products with the partners**
 - Over 90% of the alternate standards are completed
 - Over 60% of the variances are completed
 - Over 60% of the Phase 2 hazard reports are completed
- **Eight CCP missions now in process (two test flights per partner and two Post Certification Missions per partner)**
- **Extended the Sierra Nevada Corporation Space Act Agreement to the Summer of 2017 to enable an Approach and Landing flight test.**
- **Entered into a new, unfunded Space Act Agreement with Blue Origin for orbital human space transportation system development**

CCP Major Partner Milestones



- **TDRS-M (Tracking and Data Relay Satellite)**
 - TDRS-M spacecraft is in ground storage in a nitrogen-purged tent
 - Atlas V/401 launch vehicle is on contract with United Launch Alliance
 - Launch scheduled for August 8, 2017
- **SGSS (SN Ground Segment Sustainment)**
 - Delivered A5 software increment
 - New baseline delivery schedule in September to match budget availability
- **DSN (Deep Space Network)**
 - Successful support of Juno Jupiter orbit insertion
 - A total of 9 antennas arrayed in 2 groups communicated with Juno – first time for that array
 - Continuing with antenna upgrade/replacement
 - Groundbreaking in Spain October, 2015 for Deep Space Station 56 (DSS-56) and Deep Space Station 53 (DSS-53).
 - Canberra Deep Space Station 36(DSS-36) operational in October 2016





**Capture Module Prototyping/Testing
at Goddard Space Flight Center**



**Robot Subsystem - Microspine Gripper
Jet Propulsion Laboratory**

Habitation Systems

Testing on Space Station & Beyond



An integrated array of complex systems and components that include environmental control and life support systems, docking capability, logistics management, radiation mitigation and monitoring, fire safety technologies, and crew health capabilities.

Environmental Control & Life Support

- ✓ Long Duration Sorbent Test Bed: Feb. 2016
- ✓ Organic Water Monitor: Apr. 2016
- ✓ Aerosol Sampler: Apr. 2016
- Brine Processor: Dec. 2017
- Spacecraft Atmosphere Monitor: Feb. 2018
- Primary Wastewater Processor: Feb. 2019
- High Pressure High Purity Oxygen Generation: Sep. 2019
- Oxygen Recovery: ~Oct. 2019
- CO2 Removal ~Sep. 2021

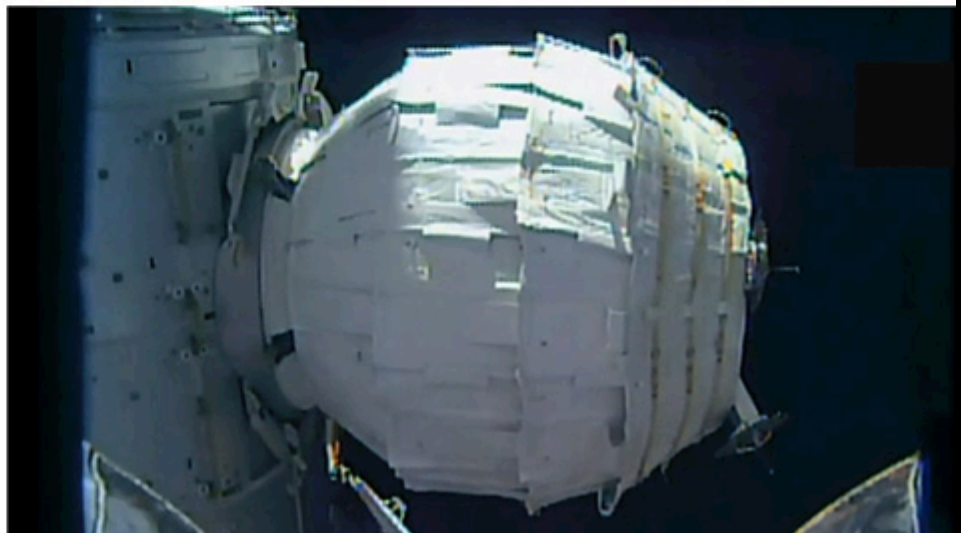
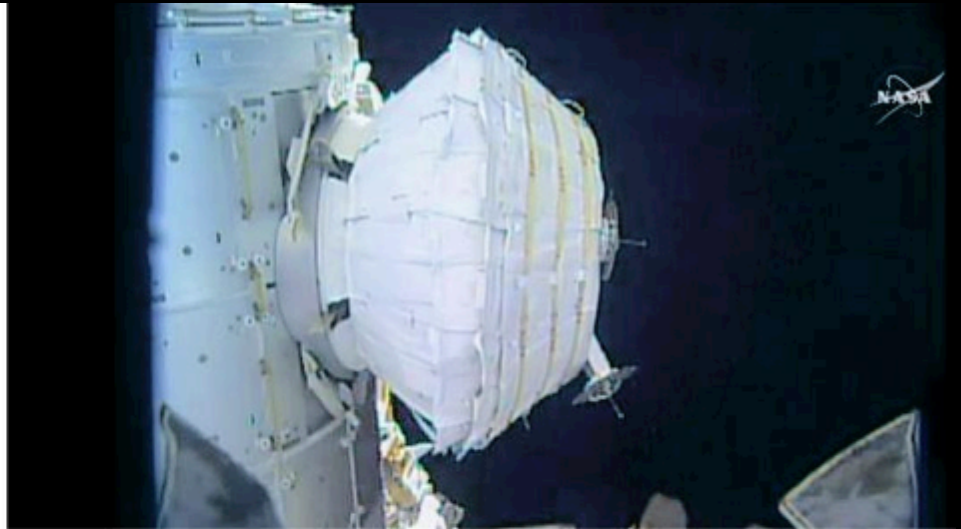
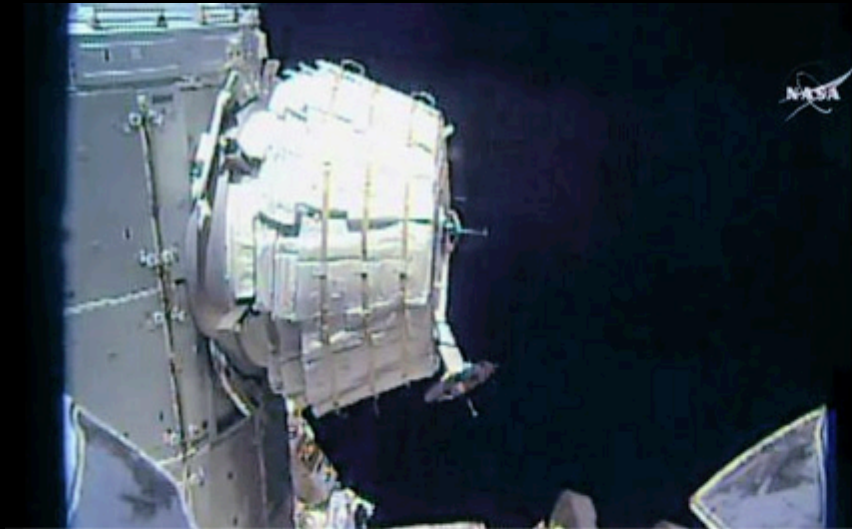
Radiation Detection & Mitigation

- ✓ Continuing operations of the Radiation Assessment Detector (RAD) on the Curiosity Rover
- ✓ Environment sensors on EFT-1, ISS, BEAM
- Environment sensors on BioSentinel CubeSat.
- Advanced Neutron Spectrometer for ISS in 2016.
- Developing Hybrid Electronic Radiation Assessor (HERA) for flight on Orion during EM-1.

Logistics Reduction

- ✓ Extended wear clothing to reduce the laundry needs
- ✓ Multi-Purpose Cargo Transfer Bag (MCTB) on ISS.
- ✓ Radio Frequency Identification (RFID) tag readers installed in ISS hatchways to inventory movement.
- Universal Waste Management System (UWMS – space toilet) in development for ISS and Orion

BEAM Expanded on Space Station – May 28, 2016



NextSTEP Phase 1 to Phase 2 Schedule



| Milestone | Schedule Estimate |
|-------------------------------------------------------------|---------------------------|
| Release Solicitation for new Proposals | April 19 <i>Completed</i> |
| Release Final Guidance to Phase 1 Performers | April 20 <i>Completed</i> |
| Phase 2 Proposals Due | June 15 <i>Completed</i> |
| Evaluation Period (Including Due Diligence/Fact Finding) | June/July |
| Selection | August |
| Negotiate and Award Contracts | September |

Active GAO & IG Audits Assignments



CY 2015

| Assignment No. | GAO & IG Active Audits |
|----------------|-----------------------------------------------------------------------------------------------|
| GAO 15-596 | SLS Cost and Schedule |
| GAO 100297 | Space Launch System and Ground Systems Development and Operations programs |
| GAO 100298 | Orion Multi-Purpose Crew Vehicle |
| IG A1500600 | NASA's Plans to Resupply the International Space Station in Light of Orbital's Launch Failure |
| IG A1500700 | Audit of NASA's Management of the Near Earth Network |
| IG A1500800 | Audit of NASA's Spaceport Command and Control System Software Development |
| IG A1501000 | Follow-up Audit of NASA's Commercial Crew Program |
| IG A1501300 | NASA's Plans to Resupply the International Space Station in Light of SpaceX's Launch Failure |
| IG A-15-014-00 | Plum Brook Station |
| IG A-14-019-00 | Agency JCL Process |
| IG A-13-020-00 | Infr. Modern., GSDO |
| IG A-13-020-00 | Infr. Modern., Comm. |

GAO Quicklook Book

SLS, Orion, GSDO, SGSS, SLS, GSDO, Orion, AARM, CCP

CY 2016

| Assignment No. | GAO & IG Active Audits |
|----------------|-------------------------------------------------------------------------------------------------------------------|
| GAO 100572 | Space Insurance Expansion |
| GAO 100663 | Use of Space Support Vehicles |
| GAO 100712 | Foreign Space Launch |
| GAO 100727 | NASA Commercial Crew Program |
| GAO 100996 | Orion Multi-Purpose Crew Vehicle (Orion), Space Launch System (SLS) and Exploration Ground Systems (EGS) Programs |
| GAO 101003 | Integration of NASA's Human Space Flight Programs |
| IG A1501000 | Audit of NASA's Management of Its Electromagnetic Spectrum |
| IG A1501300 | NASA's Management and Development of Spacesuits |
| IG A-15-014-00 | NASA's Plans for Human Exploration Beyond Low Earth Orbit |

GAO Quicklook Book with New Metrics

SLS, Orion, GSDO, SGSS, SLS, GSDO, Orion, AARM, CCP

Major Upcoming Program/Enterprise Activities Through Rest of CY 2016:

- Enterprise Build to Synchronization
- Orion CDR2 out-briefs
- SLS core stage IBR
- SLS EUS and USA RFPs
- SLS element DCRs

QM-2 Test Firing



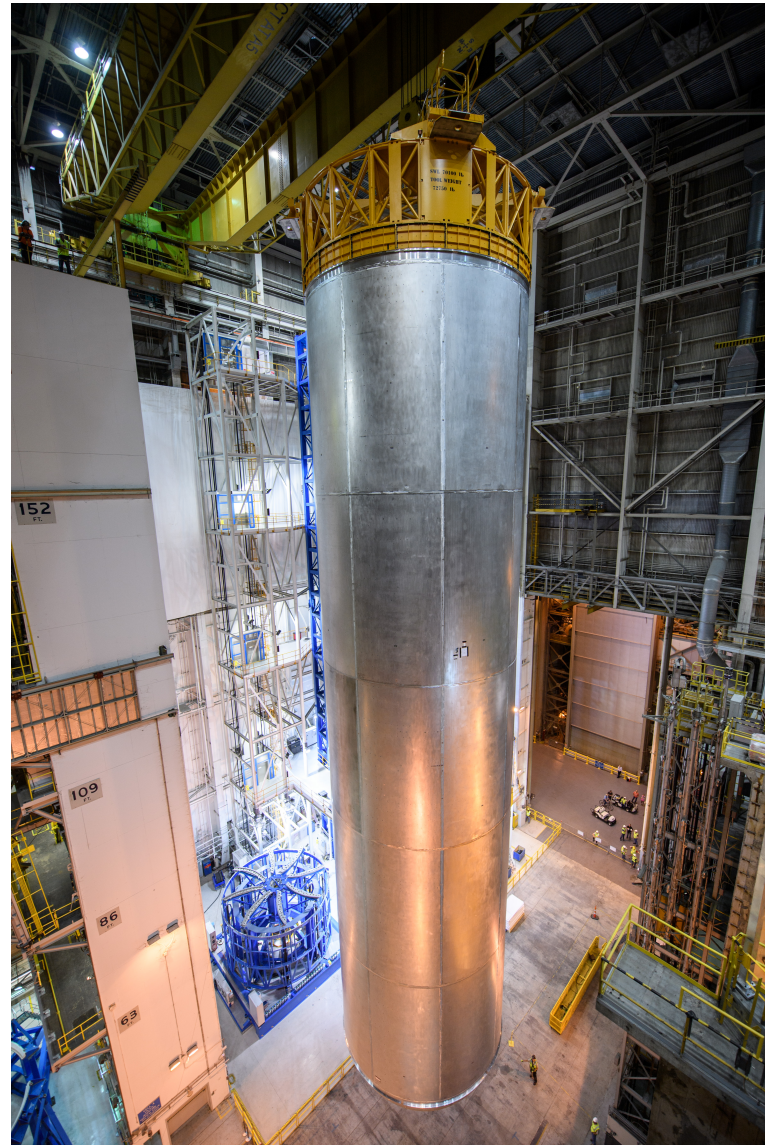
Welding on SLS Fuel Tank Test Article Completed



A qualification test article for the liquid hydrogen tank for the Space Launch System. It is being lifted off the Vertical Assembly Center after final welding at the Michoud Assembly Facility in New Orleans.

Next Step:

As four qualification articles of the core stage hardware are manufactured, they will be shipped to Marshall Space Flight Center in Huntsville, AL, for structural loads testing.

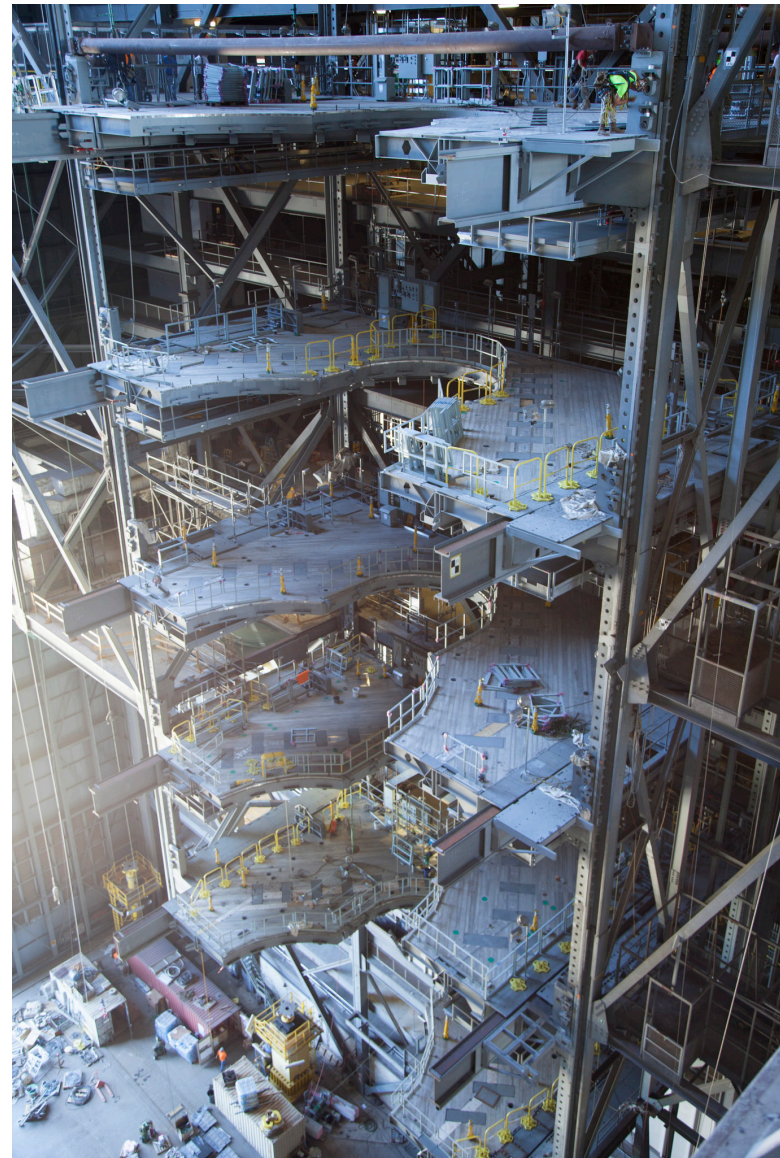


Ground Systems Development & Operations Accomplishments



Aft Skirt Purge Umbilical Purge
at LETF

A view of the south side of High Bay 3 inside the Vehicle Assembly Building at NASA's Kennedy Space Center in Florida. Five levels of new work platforms for NASA's Space Launch System are in view, with the topmost platform, F south, installed about 192 feet above the floor.



HEO Mars Planetarium Outreach



Project Overview:

- 10-minute Dome show, *Future of Human Space Exploration*, created in 2012 to support Space Shuttle retirement celebrations at the Intrepid, California Science Museum, Smithsonian, and KSC.
- Two additional planetarium shows created in English and Spanish, single and planetarium screen views: *International Space Station* and *NASA's Journey to Mars*.
- National education competition across the nation awarded students designing new human spaceflight ideas
- Partners: NASA, NIA, Obscura Digital, Rocket21, and Evans and Sutherland.

Successes:

- Planetarium production a hit with >200 planetariums, science museums and educational system domes throughout the US and internationally engaged.
- International audiences in Mexico, Israel, Singapore, Taiwan, Abu Dhabi, Austria, Poland, Germany, Canada, Czechoslovakia, Israel, and others. Videos being translated at no cost to NASA.
- 2.3M single screen views on Facebook, YouTube and NASA 360.

